

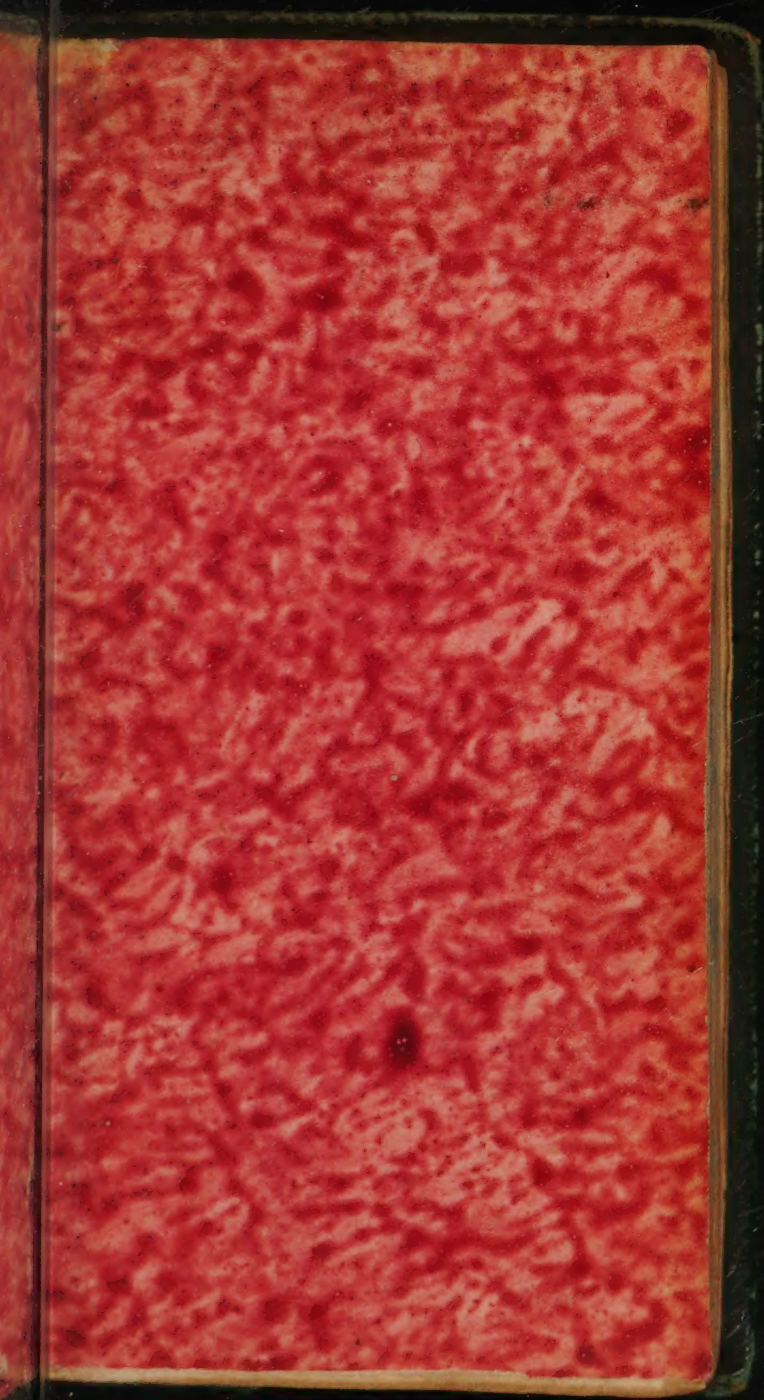
DUPLICATE  
PROPORTION











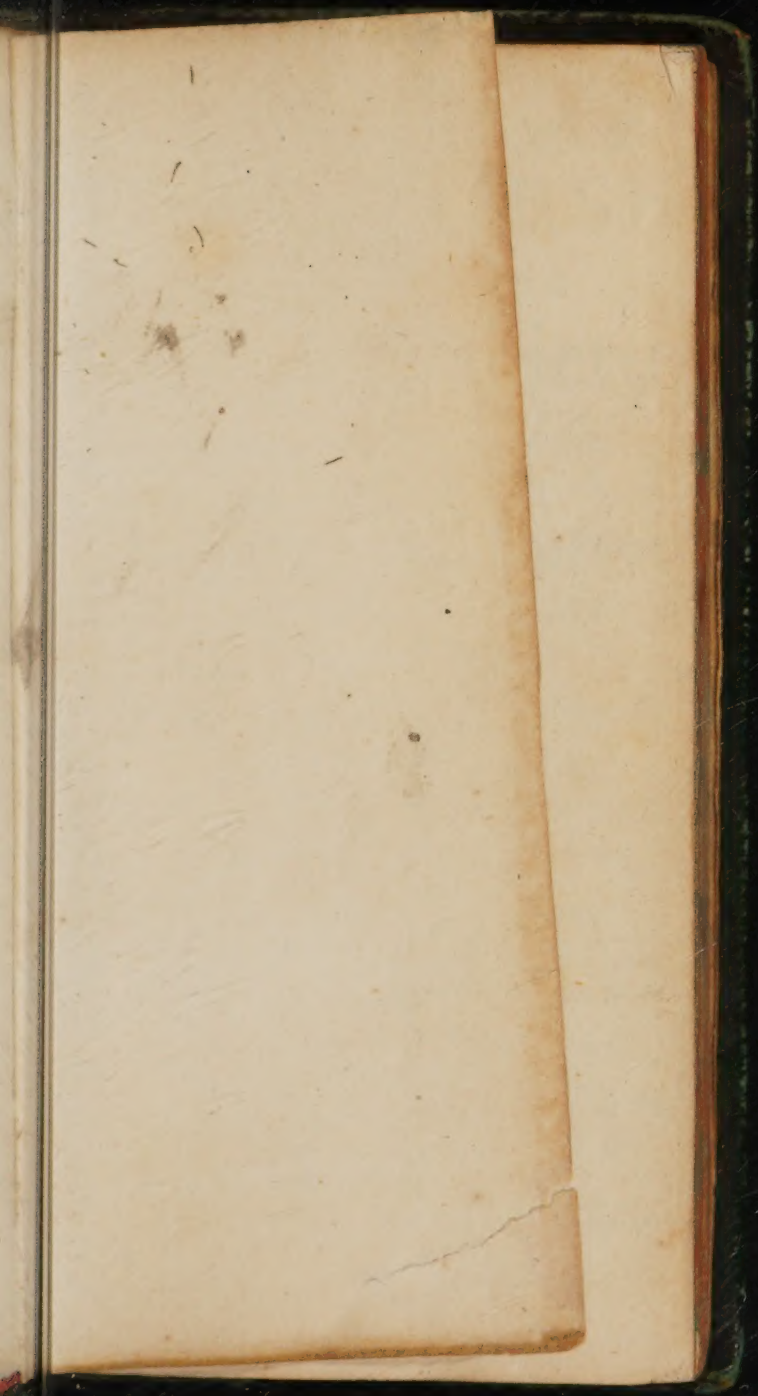
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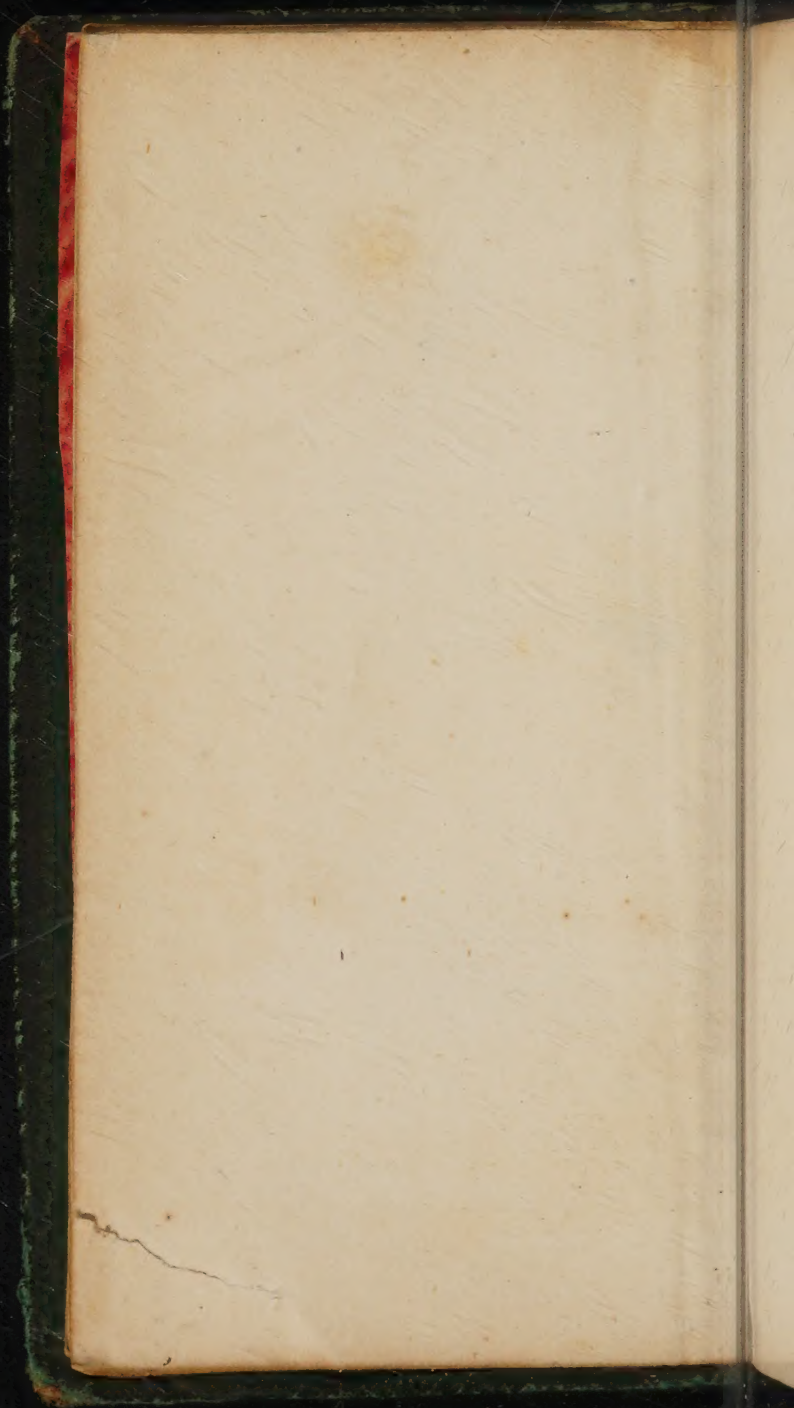
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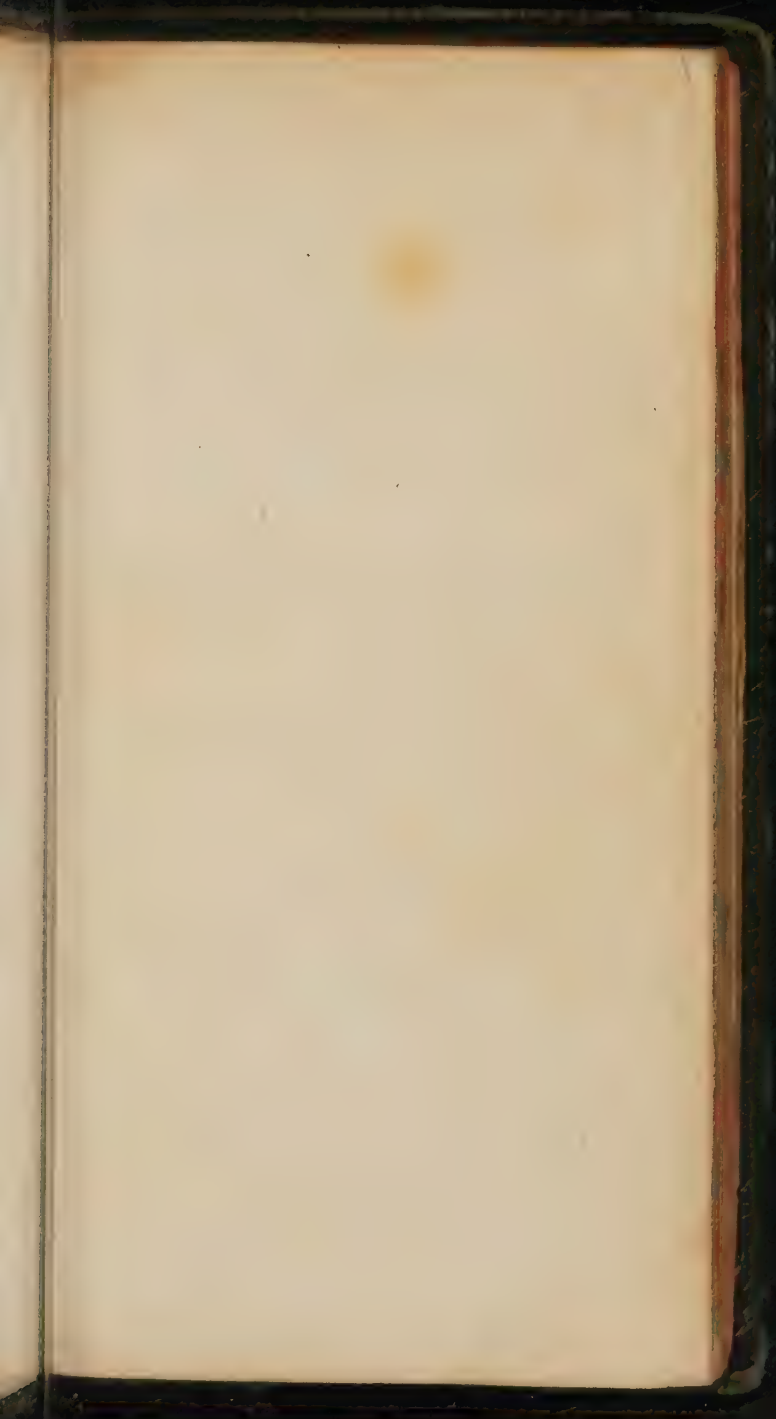
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(a) - 4 and A1  
charted to all  
misbound between  
E.P. (A2) and A3

THE <sup>47858</sup>  
DISCOURSE

Made before the  
Royal Society

The 26. of November 1674.

Concerning the Use of  
Duplicate Proportion

In sundry Important Particulars :

Together with a

*New Hypothesis of Springing  
or Elastique Motions.*

BY

Sir WILLIAM PETTY, Kt.  
Fellow of the said Society.

*Pondere, Mensura, & Numero Deus omnia fecit :  
Mensuram & Ponderis Numeros, Numero omnia  
fecit.*

L O N D O N :

Printed for John Martyn, Printer to the  
Royal Society, at the Bell in  
St. Pauls Churchyard, 1674.



Dedicatory.

Troubles have or can  
quench my affections  
to Philosophy, as no  
distances of Time or  
Place have made Me  
less than formerly,

YOUR GRACES

*Most humble, most faith-  
ful, and most obedi-  
ent Servant,*

Ult. Decemb.

1674.

WILLIAM PETTY.

( a )

To

WILLIAM

PRESTIDENA

TO THE

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...

...

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W  
L  
P  
R  
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...  
...



*To the Right Honourable*

WILLIAM

Lord Viscount Brouncker,

PRESIDENT

OF THE

Royal Society.

My Lord,



*THE Observations on the Bills of Mortality were distinctly Dedicated to a Peer of this Realm, and also to the President of the Royal Society,*  
(a 2) and

## The Epistle

and both with good acceptance: Wherefore I have also (like the Author of those Observations) Dedicated this Discourse to his Grace the Duke of Newcastle, for the reasons in the foregoing Epistle mentioned; and I now again Dedicate the same to your Lordship. First, In Gratitude for the several assistances I had from your Lordship towards the Experiments mentioned in this Discourse. Secondly, Because your Lordship is an Eminent Judge  
in

## Dedicatory.

in those Matters, a Person whose Animadversions I shall take for Kindnesses; and who is able to excuse the Errors, and defend the Truths I have delivered. Lastly, For that near half the whole Discourse relates to Shipping, Artillery, Fortresses, Sea-banks, &c. which all concern his Majesties Service, and part whereof are happily entrusted by him to your Lordships Care; I thought I might express My affection to those his Majesties Con-  
(a 3) cernments

The Epistle, &c.

cernments even by offerings,  
this my Mite unto them.  
Upon the whole Matter, I  
have layd hold on this Occa-  
sion, to Publish my desire of  
being esteemed,

My LORD,

Your Lordships most  
humble and faith-  
ful Servant

Ult. Decemb.  
1674.

WILLIAM PETTY.

E.R.

---

## ERRATA.

PAGE 6. l. 5. r. *Proportion.* p. 44. l. 1. r. *be for*  
*being.* p. 49. l. 6. r. *&c. be.* p. 49. l. 13.  
r. *moreover for viz.* *ibid.* l. 14. r. *Mice, or rather*  
*some smal Animals (whose correspondent parts*  
*are but  $\frac{1}{12}$  in length of the Horses.)* *ibid.*  
l. ult. r.  $\frac{1}{44}$  for  $\frac{1}{44}$  p. 87. l. 10. r. *Numerus*  
*for numerous.* *ib.* l. 11. r. *of for or.* p. 88. l. 8.  
r. *whereof for thereof.*

---

Thursday Decem. 10. 1674.

At a Meeting of the Council  
of the Royal Society.


**W**Hereas it was desired by  
the Royal Society, that  
a Discourse made before them by Sir  
William Petty Knight, at their  
Meeting the 26. of November  
last, might be Printed: It is this  
day Ordered by the Council of the  
said Society, That the said Dis-  
course be Printed by the Printer of  
the Royal Society.

BROUNCKER, P. R. S.

To his Grace,

**WILLIAM,**  
LORD DUKE OF  
*NEWCASTLE.*

*May it please your Grace,*

 Am comman-  
ded by the  
*Royal Society*  
to Print the Dis-  
course, which I made  
A 3 be-

## The Epistle

before them, upon  
the last Meeting-day  
of *their* last year, and  
next before that of  
their *Anniversary E-*  
*lection* : Because, as  
Drapers cut Patterns  
of their whole Cloth  
out of an End, not be-  
cause the End is bet-  
ter than the rest, but  
because it may be best  
spared; so (I suppose)  
the



## Dedicatory.

the *Society* are content, that this Exercise pass for a Sample, *pro tanto*, of what they are doing; for that the same may be conceived to consist of three parts, *viz.* The *first* being an Endeavour to explain the Intricate Notions, or *Philosophia Prima* of Place, Time, Moti-

A 4      on<sup>c</sup>

## The Epistle

on, Elasticity, &c. in  
a way which the  
meanest Member of  
adult Mankind is ca-  
pable of understand-  
ing : The *second* be-  
ing, to excite the  
World to the study  
of a little Mathema-  
ticks, by shewing the  
use of *Duplicate Pro-  
portions* in some of the  
most weighty of Hu-  
mane

## Dedictory.

mane affairs, which  
Notion a Child of 12  
years old may learn  
in an hour: And the  
*last* being, without  
Chymerical Specula-  
tions, to consider such  
points and proper-  
ties, even in *Atoms*  
(such, whereof per-  
haps a Million do not  
make up one visible  
*Corpusculum,*) as may  
A 5 give

## The Epistle

give an intelligible Account of the Nexures, Mixtures, and Mobilities of all the parts of the Universe.

In like manner, 'tis the Profession of the *Society*, to make Mysterious things plain; to explode and diffuse all insignificant and puzzling words; to

## Dedicatory.

to improve and apply  
little small threads of  
Mathematicks to vast  
uses ; and yet not to  
neglect the finest  
Consideration, even  
of *Atoms*, where the  
same is necessary.  
The which purposes  
of theirs, I venture  
to say, do as much  
differ (both as to *diffi-*  
*culty* and *dignity*)  
from

## The Epistle

from what is commonly called *Wit* (and which takes with far the greater part of Mankind,) as the skill of Drawing and Painting a Cloud or Periwig doth from that of Designing or Painting many complicated Figures of Men and Beasts in some one Table, where-

## Dedicatory.

wherein each is perfectly to express some particular passion, and all standing together to contain the true and entire Spirit of the Story represented: For, in the *latter*, precise exactness is indispensable, whereas in the *former*, not onely liberty always, but even extravagancy

## The Epistle

icy sometimes is not  
lonely tolerable, but  
laudable. And when  
I have said this; I  
withal say, that there  
is one Glory of the  
*Sun*, another of the  
*Moon*, and another  
of the *Stars*, which  
may all consist toge-  
ther, without de-  
stroying or malig-  
ning each other. And  
all



## Dedictory.

all these several Glories shine steddily in your Graces Firmament.

Being, I say, appointed to publish this Exercise, I have presumed to dedicate it to your Grace. First, because the *Society* have been pleased to order it to be published; ( I dare  
not

## The Epistle

not say, as approving  
it, but as committing  
it to Examination.)

Secondly, because  
your Grace doth not  
onely love the search  
of Truth, but did en-  
courage Me 30 years  
ago as to Enquiries of  
this kind. For about  
that time, in *Paris*,  
*Mersennus*, *Gassendy*,  
*Mr. Hobs*, *Monfieur*  
*Des*

Dedicatory.

*Des Cartes*, Monsieur  
*Roberval*, Monsieur  
*Mydorge*, and other  
famous men, all fre-  
quenting, and caref-  
sed by, your Grace  
and your memorable  
Brother, Sir *Charles*  
*Cavendish*, did coun-  
tenance and influence  
my Studies, as well  
by their Conversati-  
on as their Publick  
Le-

## The Epistle

Lectures and Writings: Much of which  
honours and helps  
ow unto your Grace,  
and have a fresh re-  
membrance of them.

Thirdly, because my  
Lord *Ogle* being now  
about to carve a sig-  
nificant Figure upon  
my Lord his Son, by  
his careful Education  
of him, I thought it a  
service:

## Dedicatory.

service to his Lord-  
ship, as well as an  
Expression of my  
Thanks for his for-  
mer acceptance of my  
Endeavours, to call  
upon him, not onely  
to instruct my Lord  
his Son in some Ma-  
thematicsk, but also to  
store and stock him  
with variety of *Mat-*  
*ter, Data and Pheno-*  
*mena,*

## The Epistle

*mena*, whereupon to  
exercise the same  
since *Lines & Num-*  
*bers*, without *those*  
are but like Lute-  
strings without a  
Lute or a Hand. For  
my Lord, there is a  
*Political Arithmetic*  
and a *Geometrical Fu-*  
*sice* to be yet further  
cultivated in the  
World; the Errors  
and

## Dedicatory.

and Defects where-  
of, neither Wit, Rhe-  
toric, nor Interest can  
more than palliate,  
never cure. For, Fal-  
sity, Disproportion,  
and Inconsistence can-  
not be rectified by a-  
ny sermocinations,  
though made all of  
figurate and measured  
periods, pronounced  
in Tune and Ca-  
dence,

## The Epistle

dence, through the  
most advantageou  
organs; much less by  
Grandisonous or Eur  
phonical Nonsence  
farded with formal  
ty; no more than v  
cious Wines can be  
remedied with Bran  
dy and Honey, or in  
Cookery with enor  
mous proportions  
Spice and Sugars  
Na



Dedicatory.

*Nam Res nolunt  
male administrari.*

These are the Reasons, why I have put your Graces Name to this Treatise; though there is a contrary reason, why it should have wholly *shun'd* your Graces sight and knowledg: which is, That your Grace might not perceive  
how

## The Epistle

how little progress  
have made in thirty  
years time upon those  
Studies. However  
hope your Grace will  
take what I have done  
for an Argument of  
my patience and per-  
severance in these  
pleasant, though pro-  
fitless, Employments  
and see, that no hete-  
rogeneous Cares and  
Trouble

---

A  
DISCOURSE  
TO THE  
Royal Society.

**F**Orasmuch as this  
*Society* has been  
censured (though  
without much cause) for  
expending too much time in  
matters not directly tend-  
ing to profit and palpable  
Advantages (as the Weigh-  
ing of Air and the like)

B

I

I have therefore, to streighten this crooked stick, bent it and my present Discourse the quite contrary way, viz. to the *Sails* and *Shapes of Ships*; to *Carpentry* and *Carriages*; to *Mills* *Mill-dams*, *Bulwarks*; to the *Labour of Horses*, and to several other particulars: The which are not only gross enough of themselves, but are also as grossly handled in this Exercise, to prevent the further imputation of needless Nicerity,

ty, and to leave room for your own further thoughts upon the same.

And forasmuch as We have been also complained of for producing nothing New, I have together with my Instances and Applications, above and hereafter mentioned, presented you as an Appendix, to what is said of *Springs* and other *Elastique bodies*, with a new Theory (as I think) of *Elasticity* it self, and that mechanically explicated in

order to make a breach on  
 this hard Rock in Philoso-  
 phy, and to chip off a little  
 of that Block which has  
 long lain thwart Us, in the  
 way of Our Enquiries. Up-  
 on the whole matter I have  
 followed the Example of  
*Elderly Divines*, who find-  
 ing their Flocks not to  
 mend their lives by per-  
 plexed Discourses about  
 Predestination, Transub-  
 stantiation, &c. betake  
 themselves at last to preach  
*Faith and Good Works,*  
*Neigh-*

*Neighbourly Love and Charity, or Doing as we would be done unto, and the like. For I have in this Exercise declined all Speculations not tending to practice, and ventured at few new Hypotheses, but that of Elasticity; rather calling upon you to review your own former Observations, and to apply your Mathematicks to Matter, so as both may be improved to the profitable purposes hereafter mentioned.*

B 3      Where-

Wherefore the Title and  
 Scope of this Exercise is  
*Several Instances, wherein the  
 consideration of Duplicate and  
 Subduplicate propoortion, on  
 wherein the consideration of  
 Sides and their Squares is of  
 use in humane affairs.* And  
 the *Instances* which I have  
 pitcht upon for this day  
 are these following, viz.

1. In the *Drawing* or  
*Driving powers*, which force  
 Ships or other bodies  
 through the water, with  
 reference to the respective

*Velo-*



*Velocities* caused thereby.

2. In the *shapes* or *sharpness* of bodies, cutting or dividing the water, through which they are *driven* or *drawn*, and in the different *Velocities* arising from thence, where the *Bodies* and *Forces* are equal.

3. In the *Strength* of *Timbers* or other homogeneous materials applied to *Buildings*, to *Carts*, or any other *Machinaments* intended for strength: And how by a *Model* to judg

the sufficiency of such *Engine* as is represented by it.

4. In the effect of *Oars* upon equal and like *Vessels*, according to their *Numbers, Length, Blades*, and *Motions* with or against the *stream* of *smooth* or *uneven* waters.

5. In the *Motion* or *Travelling* of *Horses*, on their several *Paces*, and with different *Burthens* on them.

6. In the *Strength* and *Velocity* of *Mills* and their *Wheels*.

7. In

7. In the Effects of Gun-  
powder.

8. In the Distance at  
which *Sounds* may be  
heard.

9. In the Distances at  
which *Odoriferous matters*  
may be smelt.

10. In the Distance at  
which the *Objects of Sight*  
may be seen.

11. In the time of the  
Returns made by *vibrating*  
*Pendules*.

12. In the *Lives* of men  
and their Duration.

13. In *Musical & Sound-*  
*ing Bodies*, such as *String-*  
*and Bells*.

14. In the *Effects and*  
*Motions of Fire*, and *burn-*  
*ing Spirits*.

15. In the *Rising and*  
*Falling of Bodies*, but espe-  
*cially of Water in Pumps*  
*Overshot Mills*, *Leaks in*  
*Ships*, the *Heights of Rivers*  
 at their head above their  
 fall into the Sea.

16. In *Bellows*,

17. In the *Prices of se-*  
*veral Commodities*, as *Masts*  
*Diamonds*.

*Diamonds*, large *Timber*,  
*Amber*, *Loadstones*, &c.

18. In *Mill-dams*, *Sea-banks*, and in the *Bulwarks* or *Walls* of *Fortresses*.

19. In the *Compression* of *Wooll*, and other *Elastick Bodies*, and of the *Air* within diving *Vessels*, as also in the *Effects* of *Skrew-presses* upon several *Materials*.

Having thus enumerated my several *Instances*, wherein *Duplicate*, and *Subduplicate* proportion is of great importance; I might  
 now

now fall down-right upon  
the Application of those  
proportions to each of the  
respective matters above  
mentioned. But because  
Custome hath made it al-  
most necessary to make a  
*Preface* to every Discourse,  
my *Preface* to this one *Le-  
cture* shall be such, as may  
serve me for many more;  
that is, an Explication of  
what I my self (at least) un-  
derstand by *Matter, Body,  
Figure, Place, Motion, Quan-  
tity, Quality, Habit, Time,*  
*Propor-*

*Proportion, Weight, Swift-  
ness, Force, and Elasticity;*  
which I shall do without  
imposing or scarce recom-  
mending the same to any  
other. For I would be glad,  
when any man speaks to  
me in matters of impor-  
tance, by words which he  
uses often, that he would  
first give me a *Dictionary* of  
such words, to contain  
what he himself meaneth by  
each of them. Wherefore I  
shall, as a Preface, prefix  
this Dictionary, wherein I  
dare

I dare not define *Matter* by  
*Ens*, or *Substance*, because  
 I think most men conceive  
*Matter* better than they do  
 either of these two words  
*Ens*, or *Substance*. Nor do  
 I define the words, *Think*,  
*Consider*, or *Conceive*, by the  
 words, *Soul*, *Spirit*, *Act*, or  
 the like, for the same rea-  
 son. But presuming you  
 all understand, *conceive*  
*imagine*, or *fancy* the words  
*Matter* and *Thought*, as  
 well as any other I can  
 use, I venture to say as  
 follow.



followeth , and first ,  
That

1. *Place* is the Image or  
Fancy of Matter, or Matter  
considered.

2. *Quantity*, the Fancy of  
Place.

3. *Ratio*, several Quan-  
tities considered together.

4. *Proportion* , several  
like *Rationes*.

5. *Situation*, several Pla-  
ces considered together.

6. *Figure* is *Quantity*  
and *Situation* considered  
together.

7. *Body*

7. *Body* is Matter and Figure considered together.

8. *Motion* is change of Place.

9. *Time*, the Image of Motion.

10. *Quality*, several Motions considered together.

11. *Habit*, the same Motions repeated.

12. *Likeness*, several Figures, or Qualities, and Proportions considered together.

13. *Swiftnes*s, Time and Place,

Place or Space considered together.

14. *Force* is Body and Swiftness considered together.

15. *Right* is the Image of Possession, and is to it as Place to Body.

16. *Elasticity* I shall speak of hereafter.

In the next place, I suppose all the *First Matter* of the World to be *Atoms*; that is, Matter Immutable in Magnitude and Figure. I suppose *Corpuscles* to be

as

as many Atoms joyned together, as make up a *visibile* or sensible *Object*, and that all *Figure* of *Atomes* made by their *Innate motions*. Moreover I suppose That every Atom is like the Earths Globe or Magnet, wherein are *three Points* considerable, *viz.* two in the surface, called *Poles* and one within the substance, called *Center*, or rather *Byas*, because in Atoms we consider neither *Magnitude* nor *Gravity*.

These

These Atoms also may have  
 each of them such Motions  
 as *Copernicus* attributes to  
 the Earth, or more. Lastly,  
 Motion to or from a Point  
 makes a *streight Line*, and,  
 about it, a *Circle*. But from  
 the Center to several Points  
 in the *Circle*, is *Angle*. We  
 further say, that the moti-  
 ons of *Corpuscles* are com-  
 pounded of the abovemention-  
 ed motions of Atoms ;  
 and the motions of bigger  
 and Tangible Bodies (*viz.*  
 their qualities) are decom-  
 pounded.

pounded out of the *Motions*, *Situation*, *Figure*, and *Magnitude* of Corpuscles, and that out of, and by the premisses all *Phænomena* in nature must be solved. And this is all the Preface I shall trouble you with, being (as was said) the *Dictionary* wherein to find what I mean by every material word I intend to use in this ensuing Exercise, which we thus begin *viz.*

The

## The First Instance,

*Wherein Duplicate, and Sub-  
duplicate Ratio or Pro-  
portion is considerable, Is*

*I*N the *Velocities* of two  
equal and like *Ships*;  
which *Velocities*, I say, are  
the *square Roots* of the  
*Powers* which either drive  
or draw them; as, for ex-  
mple, Such two *Ships*  
having sails near double  
to

to each other, or as 49  
 25, the Velocity will be  
 5, the square Root of 25  
 unto 7, the like Root  
 49. Again, if the sails be  
 near triple, or as 49  
 16, there the Velocity shall  
 be as 7 (the Root of 49)  
 to 4 (the Root of 16.) So  
 as a *quadruple Sail* is re-  
 quisite to *double* swiftnesse  
 and *nonuple* to *treble*; that  
 is, The sails must be in du-  
 plicate proportion to the  
 swiftnesse of the Ship; or  
 this, in subduplicate to  
 that. Again



Again, let there be two  
 Ships of Equal sails, but of  
 unlike or unequal sharp-  
 nesses, suppose the head of  
 one extremely obtuse or  
 quite flat, and the head of  
 the other to be an *Isoceles*  
*Triangle* added thereunto ;  
 say, the swiftneſs of these  
 bodies shall be as the Roots  
 of the Perpendicular of  
 that Triangle to the Root  
 of half the Base, or half  
 breadth of the same. Se-  
 condly, Or if the same Tri-  
 angular head be cyphered  
 away

away into an Angle from  
 bottom to top ; then,  
 the Root of the same Per-  
 pendicular is to the Root  
 of the Depth or Thick-  
 ness, so are the Velocities.  
 Thirdly, If the said head  
 be cyphered both ways  
 together, then the Pro-  
 portion of Velocities shall  
 be as half of one of the  
 above mentioned Propor-  
 tions added to the other  
 whole Proportion : *Ex. gr.*  
 Suppose the Perpendicular  
 of the triangle-head

be 36, the half breadth 9,  
 and the whole depth be 4;  
 then the one Proportion  
 shall be as 6, the Root of  
 36, to 3, the Root of 9: The  
 half of which Proportion  
 is as 6 to 6; and the other  
 Proportion is as 6, the  
 Root of 36, to 2, the Root  
 of 4. Now add the Pro-  
 portions of 6 to 6, to that  
 of 6 to 2, the sum will be,  
 as 36 to 12, or as 3 to 1.

Fifthly, Suppose two Pa-  
 rallelepipedons of unequal  
 heads or resistances, *Ex.gr.*

C

as

as 8 to 5, or 64 to 40 : And  
 suppose the Sail on the bigger  
 ger, to that on the lesser  
 to be as 9 to 4, or 72 to 32  
 then the Velocity of the  
 bigger shall be to the Veloc  
 city of the lesser, as the  
 Root of 45 is to the Root  
 of 32. For if the Resistanc  
 ces be as 64 to 40; then  
 if the sail of the bigger to  
 that of the less were pro  
 portionable to the Resi  
 stances, the sail of the less  
 should be 45, whereas we  
 suppose it but 32. Where  
 force

Fore the Velocity shall be  
 as the Root of 45, which is  
 almost 7, to the Root of  
 2, which is about  $5\frac{1}{2}$ , that  
 is, as about 14 to 11.

*Memorandum*, That wet-  
 ting of Sails (by lessening  
 the intersperst apertures  
 between the threds of the  
 sail-cloth) doth make the  
 sail, as it were, bigger;  
 which biggerness may be  
 known and measured by  
 the increase of the Ships  
 velocity upon such wet-  
 ting. For, if the Ship should

move one tenth part quicker  
 er after wetting than befor  
 fore, we may conclude th  
 Sails are swollen to th  
 equivalent of about  $\frac{1}{5}$  part  
 bigger; for 100 ( whose  
 Root is 10 ) exceeds 8  
 whose Root is 9, by about  
 $\frac{1}{5}$  of 100.

By these ways the differ  
 rent Velocities, arising  
 from the different Trim  
 the same Ship, may be al  
 so computed, the best Trim  
 being that which makes  
 least resistance, *ceteris pa  
 ribus.* Now

Now, having said thus much of the Effects of Sharpness and Sails, (the two principal causes of Velocity in shipping, and unto which all others may be referred;) I shall add, That the want of these two Advantages are the chief cause, why short, bluff, undermasted Vessels sail cheaper than others.

For suppose two Ships of equal burthens, but of unlike dimensions, the main Beam of the one be-

ing scarce  $\frac{1}{3}$  of the Keele  
length, and in the other,  
full  $\frac{1}{5}$ <sup>th</sup>; I say first, that the  
Hull of the latter shall contain  
 $\frac{1}{3}$  part more than that of the  
former, and the advantage  
as to sailing shall be scarce  
 $\frac{1}{8}$  part. Again, suppose, that  
sharper could carry  $\frac{1}{2}$  as  
much sail more as the bluff  
fer, whereof the advantage  
in sailing would be  $\frac{1}{6}$  part  
more, in all  $\frac{1}{3}$ . Now, whereof  
the Sails are as 2 to 3  
the Masts and Yards must  
be as 4 to 9 in substance ;  
and



and in value much more :  
 And where the Masts and  
 Yards are as 4 to 9 in  
 weight and bulk, the Cord-  
 age and Rigging must be  
 answerable : And where  
 the Masts, Yards, Sails, and  
 Rigging are great, the  
 Wind-taught of the Ship  
 will correspond, and will  
 require proportionable Ca-  
 bles ; and the weight of  
 the Anchor must follow the  
 size of the Cable, and the  
 number of hands must be  
 proportionable to all the

premisses : So as the one  
 Ship will cost at least  
 double as much as the o-  
 ther, and will fail at double  
 charge of Wages and Vi-  
 ctuals, Ware and Tare, &c.  
 Now if no trading Ship be  
 (one time with another )  
 above  $\frac{1}{10}$  of her whole  
 reign under sail, or 6 days  
 in 60, suppose the sharper  
 and larger-sail'd Ship fail  
 in 4 dayes what the other  
 performs in 6 ; the diffe-  
 rence will be but 2 dayes  
 in 60, or  $\frac{1}{30}$  part of the Wa-  
 ges,

ges and Victuals, and other charges; whereas the charges is supposed to be more than double. I say, this consideration is of great weight in Vessels of burden, especially such as carry gross and cheap bulky Commodities, neither liable to damage or perishing: Of which goods 7 parts of 10 of all Sea-carriage do consist. But on the other hand, where safety against Enemies, speedy dispatch upon im-

C 5.            important

portant occasions, or pre-  
 occupation of a Market are  
 in the case, there sharpness  
 and great Sails may be ad-  
 mitted to the greatest pro-  
 portions practicable.

Having thus digressed  
 I mind you that we said  
*Velocities are the Roots of*  
*Resistances and Extent of*  
*Sails, &c.* It may be well  
 askt, How we know the  
 same, since that very few  
 Seamen or Shipwrights, ei-  
 ther in their writing or dil-  
 courses seem to understand

or own this important Position. To which I answer, that I have by many Observations, Calculations, and Comparisons, found the same to be *præter propter* true, although there be many circumstances which intermingle themselves in this Experiment, so as to disturb and confound it: As namely, The ill placing of Masts, The ill cutting and standing of Sails, The ill Trim of the Vessel, with the Cleanness or Foulness  
of

of the same; The Sails  
 more or less worn or wet;  
 as also taught or slack Rig-  
 ging, &c. Wherefore not  
 onely to avoid these last  
 mentioned Intricacies, but  
 also to make these Positions  
 Examinable by every one  
 that desires it; I say, that  
 the different Velocity of  
 Bodies ( of several sharp-  
 nesses, and as drawn or dri-  
 ven by different Powers of  
 knocks or falling weights, )  
 have been by my self and  
 others much experimented

in

In large *Canales*, or *Troughs*  
 of water, fitted with a con-  
 venient Apparatus for  
 that purpose, and by no  
 man more, nor more judi-  
 ciously, than by the Right  
 Honorable the Lord *Brounc-*  
*ker*, President of this So-  
 ciety. For I do not think  
 it hard to conceive, that  
 Weights and Sails are pow-  
 ers of like Effect, and redu-  
 cible to the same Principle;  
 so as if a Body have moved  
 in double velocity, when  
 drawn by a quadruple  
 weight;

weight ; and in triple, wheer  
 by a noncuple weight ;  
 a doubt not but the same  
 will hold in Sails, or other  
 impellent Powers of the  
 same proportions.

And for the further clearing  
 ing or easier trying hereof  
 I offer two small Machina  
 ments heretofore made in  
 this Society : The one, to  
 measure the Velocity of the  
 Wind, and the other its  
 Power or Equivalency to  
 Weight ; whereby it did  
 and will appear, when the  
 wind



wind is of double velocity,  
it will stir a quadruple  
weight ; and the like in o-  
ther cases according to the  
proportions of Roots and  
Squares above mentioned.  
The same may also be seen  
even in any good Turnspit-  
Jack , where a quadruple  
weight makes double Velo-  
city (at the same distances  
of Time from the begin-  
ning of the Motion) both  
in the time of the Weights  
descent, as also in the Revo-  
lutions of the Fly, and each  
in-

termediate Wheel. Now  
 perhaps the reason of these  
 Phænomena may be here  
 expected; to which I an-  
 swer, that the many parallel  
 Instances above and here  
 after mentioned, do, like  
 concurrent witnesses, prove  
 the premisses, at least as to  
 any practical use. And as  
 for giving other reasons  
 (which I take to be Ex-  
 plaining this Subject from  
 the very first Principles of  
*Atomical Matter, and Moti-*  
*on*) I leave it to discourse

is too long for this Exercise.

## The Second Instance

*in the Strength of Timber,  
&c.*

Et there be Square Rods  
— or Pieces made of any  
Clean Timber, or other Ma-  
terials, whose Ends let  
be supported with conve-  
nient Blocks or *Fulcra* :  
These Rods in Experience  
will bear weight hung in  
the

the middle of them, according to the proportion of their lengths or distances between the *Fulcra*; that is to say, a Rod A. being double length to the Rod B. will bear  $\frac{1}{2}$  the weight which B can bear; and being of triple length, it will bear one third; & sic cæteris. Again, let two those equal and alike square Rods be placed one upon the other (so as to touch and fit,) then the two together shall bear 4 times

as much as one alone, and  
 three of them, placed as a-  
 fore-said, shall bear nine  
 times as much, and so on  
 in proportion of Roots to  
 squares. Again, lay the  
 same two Rods side by side,  
 to each other, then they  
 shall bear but double, three  
 shall bear triple, and so  
 forward, in *Arithmetical*  
*proportion*. From whence  
 it follows, that four of them  
 placed square, shall bear  
 eight times as much as one  
 alone. But if the same four  
 Rods

Rods taken as One, being  
of double length making  
Octuple quantity to One  
they shall bear but four  
times the weight of One  
alone. So as two like por-  
ces of Timber, that are  
cubical or triplicate pro-  
portion of their Sides, are  
strong but according  
duplicate proportion, as  
the Squares of their respec-  
tive Sides; and consequently,  
to have like Vessels  
(differing in Content  
the Cubes of their like  
Sides

sides) equally strong, the  
 timber of which they con-  
 sist must be *Quadrato-qua-*  
*ratic*; that is to say, a  
 ship of 400 Tuns, equally  
 strong with one of 50,  
 must have not only 8 times  
 as much Timber in it, but  
 6 times; which is seldom  
 or never done. Which de-  
 fect is the true Reason, why  
 great Shipping is both  
 Dearer and Weaker than  
 small Shipping, (no Ship  
 in the world being so  
 strong as a Nutshel;) I say,  
*Weaker,*

*Weaker*, for what is here  
 said; and *Dearer*, for what  
 shall be said hereafter  
 the sixteenth Instance  
 Masts, Diamonds, &c. And  
 on the other hand, if the  
 Timbers were Quadrat  
 quadratic, then the Ship  
 of 400 Tuns would be  
 loaden with her own Ma  
 terials; if the Ship of 5  
 Tuns were not over-tim  
 bered.

Now, for not well un  
 derstanding these matters  
 many men designing Em  
 gine



nes of strength, do make  
 odels of such Machina-  
 ents by a Scale (suppose  
 herein an inch represents  
 foot,) by which the Mo-  
 el is the  $\frac{1}{1728}$  part of the En-  
 ne intended : And there-  
 on they conceive, that if  
 e Model be strong e-  
 ough to bear  $\frac{1}{1728}$  part of  
 hat the great Machina-  
 ent is intended to bear,  
 at then the said great Ma-  
 inament will be strong  
 ough. Whereas indeed  
 e Model must bear the  
 full

full  $\frac{1}{144}$  of what is intended  
 for the great Machinements  
 otherwise great mischief  
 will appear in the Work  
 Wherefore the Square  
 the Linear Difference be-  
 tween the Model and the  
 gin, is the measure and way  
 of trying the strength and  
 sufficiency sought for: The  
 ignorance whereof has  
 made many a poor Prac-  
 titor. Upon these Prin-  
 ciples, a Cask which will hold  
 a Tun, ought to have  
 times as much Timber

, as the Cask which holds  
 nely a Barrel, or  $\frac{1}{8}$  of a  
 un; provided one be as  
 strong as the other (which  
 not usually seen.) For the  
 bigger Vessels, *Carts*, &c.  
 they are usually the weaker,  
 compar'd with the strength  
 of the lesser; which appears  
 also in *Animals*, whose  
 strength is as the Square  
 roots of their weights and  
 substance, viz. if 1728.  
 were equiponderate  
 to one Horse, the said Horse  
 is but  $\frac{1}{144}$  part as strong as  
 D all

all the said Mice.

From these considerations the Scantlings of Timber in Buildings must be adjusted; as for example Let the Walls of any Room be infinitely, that is, sufficiently strong; let the length and the breadth of the Room be given: Now suppose the Room is to be made so strong, as that every foot and a half square shall bear a Man, and that  $31\frac{1}{2}$  square feet should bear a Tun weight, (re-

konin

oning 14 men to the  
 un : ) Lastly, let the  
 strength of the Timber be  
 so given. Now the Que-  
 sions are, to find the  
 cantlings of the Girders,  
 use, &c. first in square  
 pieces, and afterwards by  
 tering the Squares into  
 ore advantageous oblong  
 sizes; as for example,  
 et the Room be supposed  
 6 foot long and 20 broad,  
 iz. 520 foot in the *Area*,  
 nd able to receive about  
 50 men, and to bear a-

bout 16 Tuns. Suppose  
 the Timber be such,  
 whereof a Rod of an im-  
 square, and 20 foot long  
 will bear  $\frac{1}{20}$  part of an hun-  
 dred weight; or, that  
 such Rods, or a Board  
 20 inches broad, and  
 foot long within the wall  
 an whole hundred weight  
 and so the whole Floor con-  
 sisting of about 16 such  
 Boards, but 1600. Now  
 the same Board were planed  
 of 4 inches thick, it would  
 bear 16 times 1600 or 25  
 hun

hundred weight: If 5 inch-  
 , 400 hundred weight:  
 but the whole weight de-  
 signed being but 325 hun-  
 dred, some size between 4  
 and 5 inches thick will  
 suffice in this case, where  
 we suppose the Floor to be  
 of planck without Gise or  
 order. Next, suppose in-  
 stead of this Planck there  
 be used Gise of double  
 thickness to the said  
 planck, and placed at qua-  
 druple distance; I say, the  
 effect and Strength will be

E. 3. the

the same with half the stuff  
 And I also say, that a  
 Girder alone of 18 inches  
 square, and 20 foot long  
 is near Equivalent to the  
 17 Gises of 9 inches deep  
 and  $4\frac{1}{2}$  broad-abovemen-  
 tioned; which Girder has  
 but half the stuff which the  
 Gise had; as the Gise does  
 contain but half the stuff  
 which the  $4\frac{1}{2}$  inch-Plank  
 first mentioned did con-  
 tain. Which saving  
 stuff is the reason of divid-  
 ing Plank into Girders  
 Girders



ise, and Board. Where  
 note, that these Proporti-  
 ons and Scantlings are not  
 offered as exact and best  
 for practice, but onely to  
 intimate the method of in-  
 quiring into these matters.  
 so useful in the world.

### The Third Instance

In the *Oars of a Boat, &c.*

**T**O determine or make  
 a good estimate of the  
 power of *Oars*, I first, for  
 D 4 easier

easier calculation, suppose  
 a Paralellipedon-Box  
 or Vessel, of breadth fit for  
 a pair of Skulls, *viz.* of a  
 bout 5 foot broad, and of  
 length sufficient for 9 such  
 Skulls or Oars, *viz.* about  
 30 foot long, and one foot  
 deep, and to draw but  
 three inches water. Next  
 I suppose, that every Skull  
 with his Skulls and  
 Bench, &c. their weight to  
 be equivalent to three Cu-  
 bical foot of water; so as  
 every pair of Skulls (with  
 its

its appurtenances) depref-  
 es or finks the Veffel  $\frac{1}{50}$  of a  
 Foot, or about  $\frac{1}{4}$  of an inch.  
 Now, fuppofe alfo a fmooth  
 calm ftanding water, in  
 which one Rower will row  
 his Veffel 12000 foot, or  
 above two miles in an hour  
 or 3600 feconds; I fay then,  
 that, if one *Remex* or Skuller  
 move 12 quarters or 3 inch-  
 es draught, 12000 feet for-  
 ward in 3600 feconds; then  
 like Rowers fhall move  
 the fame Veffel, drawing  
 5 quarters, or  $3\frac{3}{4}$  inches  
 D 5 of

of water, the same 12000 feet, in 1800 seconds plus 360 seconds, or in all, 2160 seconds: And that 9 shall row the same Vessel, as the Root of 21 to the Root of 108, which is, as near 3 to 7, or in  $\frac{3}{7}$  of the time that one Rower alone could have done the same. Again suppose each Oar lengthened from two to three, and that as many strokes are made in the same time before; then the Velocity shall increase proportionably. B

But suppose, that the Oars remain of the same length, but that the *Blade* be doubled; then the Velocity shall increase but according to the Roots of that doubling, or as 10 to 7, or 7 to 5, &c. supposing still the same number of Strokes, within the same time, in every Case or Experiment.

Again, suppose these Experiments be made not in still water, but in water which runs 6000 foot an hour;

hour; then, *against* the  
stream the Velocity will be  
lessened by one half, and  
accelerated answerably  
*with* it.

Lastly, if the said water  
be so rough, as that the  
Vessel heaves and sets, sup-  
pose 20 degrees of the Qua-  
drant in it; then, foras-  
much as the Boats way will  
be encreased as much as the  
*Tangent* of 20 degrees ex-  
ceeds the *Radius*, the way or  
Velocity of the Boat must  
abate proportionably.

The

## The Fourth Instance

In the *Motion of Horses.*

Suppose an Horse can travel 5 miles an hour with 200 pound burthen on his back ; then with half the said burthen he shall travel 7 ; and with double but three miles and a half. Again , suppose a Horse with 200 pound burthen can endure to travel 10 hours *per diem* ; then with

with half the same burthen  
 he may endure 14 hours  
 and with double burthen  
 hours. Lastly, suppose  
 Horse (as Race-horses) can  
 run after the rate of four  
 miles in  $\frac{1}{8}$  of an hour, or  
 32 miles *per* hour, then  
 they can run about 6 miles  
 $\frac{1}{28}$  in  $\frac{1}{4}$ , or after the rate of  
 24  $\frac{1}{7}$  miles *per* hour; and  
 in one half an hour can run  
 8 miles, or after the rate of  
 16 miles *per* hour; and  
 in a whole hour can run  
 12  $\frac{1}{14}$  miles; and in 2 hours  
 can



can run 16 miles, or 8  
miles *per* hour; and in 4  
hours can run 24 miles, at  
6 miles *per* hour; and in  
8 hours 32, or 4 miles *per*  
hour; and in 16 hours  
may go 48 miles, or 3  
miles in an hour. All  
which agrees well enough  
with Experience.

The

The Fifth Instance,  
In Mills.

**W**Here the wind blows  
suppose, on a *Saw-  
mill*, in double Velocity  
there the Saw-mill, which  
carried but one Saw  
shall carry four; If treble  
shall carry nine. And the  
like is true of water gush-  
ing out upon the floats of  
Under-shot Mills; as may  
be seen in the Stampers of  
Paper-Mills, the Stocks of  
Fulling-

Fulling-Mills; and other  
Works of the like nature.

The Sixth Instance,

In Gunpowder.

**T**He way of a Bullet,  
shot out of a good  
Gun, is as the square Roots  
of the quantity of the Gun-  
powder fired; I say, of  
*powder fired*, because what  
goes out unburnt, goes ra-  
ther as Shot than Powder;  
and the Length of Guns sig-  
nifies only the constraining  
of

of the Powder within the  
 Lines of Direction, till it  
 be all fired : The use of  
 hard ramming and screwing  
 of Guns, being also the  
 same ; and the excellency  
 of Powder being to fire  
 quick, and before it goes  
 out of the Gun. I say there-  
 fore, the Velocities cause  
 by Gun-powder are as the  
 Roots of the Powder fired  
 that is to say, 4 pound of  
 Powder, all equally fired  
 within the Piece, shall car-  
 ry a Bullet twice as far as  
 one

one pound shall do ; and  
 in *Time*, as 10 to 7 ; which  
 last mentioned numbers  
 are the Roots of the double  
 Distances afore-mentioned.  
 Now, if the Capacity of the  
 Concave of Guns ought to  
 be, as the Weight of their  
 Bullets or Powder ; then, if  
 the just length of any one  
 Gun hath been well found  
 by good Experimentation,  
 then may also be known  
 the length of every Gun  
 for every Bullet respective-  
 ly. As, for example, sup-  
 pose

pose a Gun, that carries  
 Ball of 5 inches Diameter  
 be 10 foot long in the Con-  
 cave, then the Content of  
 the said Concave will be  
 3000 Cylindrical inches.  
 Now the question is, how  
 long must the Piece be  
 which carries a Bullet  
 7 inches Diameter? I say  
 that forasmuch as the  
 Weight of the 5 inch Bul-  
 let, to that of 7, is as 125  
 to 343; the Concave of the  
 greater Gun must be in  
 the same proportion to

1000, viz. 8232 like inches,  
 as it may contain and  
 be a proportionable quan-  
 tity of powder : Which  
 8232 being divided by the  
 Area of the Bullet, 49, the  
 Quotient will be 168 inch-  
 es, or 14 foot ; that is (to  
 speak shortly and plainly)  
*The Length of Guns must be  
 measured by the Diameters  
 of their respective Bullets.* I  
 cannot say, I have tried the  
 effects of Gunpowder to be  
 in the abovemention'd pro-  
 portion, but have credibly  
 heard

heard it to be so ; and been  
 cause of the Similitude of  
 Sails, Weights, Knocks, and  
 the other points above describ  
 scribed, unto this of Gunpowder  
 powder, I believe it ; and  
 recommend it to your further  
 ther thoughts and experimen  
 ence.

### The Seventh Instance.

#### Of Sounds.

**L** Et there be many *Equ*  
*Sounds* ; I say, that th  
 Distances, at which the  
 ma



may be heard, are the  
roots of the Numbers of  
such Sounds. For, four  
Musquets will be heard  
twice as far as one, and  
nine thrice; and so of the  
rest. By which reckoning,  
the hearing of some of our  
fleets Engagement with  
the *Dutch* even to *S. James's*  
mark near this City is ea-  
sily solved; and the truth  
of that Observation doth  
reciprocally countenance  
this Doctrine. For sup-  
pose both Fleets (consist-  
ing

ing of two hundred Ships  
 great and small) had  
 about 12000 pieces of Ordnance  
 on board them  
 which at a *Medium* suppose  
 to be Demi-Culverins  
 Suppose also, that a Demi-  
 culverin, with the same cir-  
 cumstances of Wind and  
 Air, may be as easily heard  
 five miles, as the said Em-  
 gagements were heard 10  
 miles. Then I say, that  
 1024 of the said 12000  
 Guns firing together,  
 very near the same time  
 might

might (as they were) be  
 well heard 160 miles; and  
 that about 4000 such Guns  
 might as well be heard 300  
 miles, as one Demi-Cul-  
 verin five miles; which last  
 point I add, to prevent the  
 unbelief of a probable mat-  
 ter, when it shall happen.  
 Now what effect this had in  
 the *Popes* Presage of the  
 Battel of *Lepanto*, I know  
 not.

E

The

The Eighth Instance  
Of Smells

I Say the same of Smells  
viz. that the Distance  
at which they are perceived  
are the Roots of the Quan-  
tity of the Matter out of  
which they are emitted  
which Doctrin I apply to  
solve what I once did hard-  
ly believe, viz. that Ship  
coming from *America* to-  
wards *Portugal*, did smell  
the *Rosemary* and other  
odors

doriferous herbs 60 miles  
 off from the Land : The  
 which seems not only cre-  
 dible, but very likely. For,  
 if a foot square of a Rose-  
 mary-Field may be smelt  
 one Perch or Rod (whereof  
 20 make a mile,) then a-  
 bout 8000 Acres of Land,  
 hereon such sented Plants  
 to grow (or a piece of  
 land about 4 miles long,  
 and 3 miles broad ; or 6  
 miles long, and 2 miles  
 broad ) may be smelt 64  
 Miles : And 72000 Acres  
 E 2 of

of the like Land, or a parcel of such Land about 1000 miles square, may be smelted as many *leagues*, or near 200 miles. And this Consideration I pitch upon, as one of the grounds whereupon I would build a Dissertation concerning the Influence of the Stars, and other Celestial or remote Bodies upon the Globe of the Earth, and its Inhabitants both Men and Brutes.

## The Ninth Instance:

Concerns *Visible Objects*.

Say also, that four equal  
and like *Candles* will  
give light but twice as far  
as one, and 9, thrice as far;  
and that 16 will also en-  
lighten but 4 times as far as  
one, &c. And if a Flag or  
Ships-Vane of a yard square  
may be seen a league off  
Sea, it must be 2 yards  
square, or 4 square yards

E 3

to

to be seen 2 leagues, and  
 so forward. But whoever  
 will make experiment here  
 of, must first consider, how  
 many miles in thickness con  
 a Middling, Clear, and Di  
 aphanous Air do make an  
 Opaque. For we find, that  
 although a very thin plat  
 of clear Glafs seems to hin  
 der our sight of near Ob  
 jects but very little; yet  
 we also know, that great  
 number of them (suppos  
 one hundred) can scarce  
 be seen through at all

Here



Hereunto also must be ad-  
 ded the Consideration of  
 the Convexity of the Earth;  
 and then I doubt not, but  
 his Doctrin (of Roots and  
 Squares) rectified and cor-  
 rected with the two addi-  
 tional Considerations last  
 mentioned, will hold con-  
 cerning Visible and Lucid  
 Bodies, as was above pro-  
 pounded.

## The Tenth Instance,

*In the Time of the Vibrations  
of Pendules.*

**T**He times in which the  
Returns of a *Vibrating  
Pendulum* are made  
are the Roots of the Dis-  
tances between the Cen-  
ter of the Pendulum, and  
the Center upon which it  
moves. I shall need to  
make no application of this  
Truth, since we all enjoy  
that

the benefit of it in our more regulated Clocks and Measures of Time, which are now in common use, and from whose Improvements we may most hopefully expect a better measure of *Longitude* upon the Surface of the Earth. The further uses which may be made hereof, (it being a very simple and examinable Experiment) is to witness and give evidence to other the more abstruse and complicate Positions, which

are of the like and parallell  
Nature.

### The Eleventh Instance

In the *Life of Man, and its  
Duration.*

**I**T is found by Experi-  
ence, that there are  
more persons living of be-  
tween 16 and 26 years old,  
than of any other Age or  
Decade of years in the  
whole life of Man (which  
*David and Experience* say

to

to be between 70 and 80 years:) The reasons whereof are not abstruse, *viz.* because those of 16 have passed the danger of Teeth, Convulsions, Worms, Rickets, Measles, and Smallpox for the most part: And for that those of 26. are scarce come to the Gout, Stone, Dropfie, Palsies, Lethargies, Apoplexies, and other Infirmities of Old Age. Now whether these be sufficient reasons, is not the present Enquiry; but

but taking the afore-menti-  
 oned Assertion to be true ;  
 I say, that the Roots of eve-  
 ry number of Mens Ages  
 under 16 ( whose Root is  
 4 ) compared with the said  
 number 4 , doth shew the  
 proportion of the likely-  
 hood of such mens reach-  
 ing 70 years of Age. As  
 for example ; 'Tis 4 times  
 more likely, that one of 16  
 years old should live to 70,  
 then a new-born Babe. 'Tis  
 three times more likely,  
 that one of 9 years old  
 should

could attain the said age  
 of 70, than the said Infant.  
 Moreover, 'tis twice as like-  
 ly, that one of 16 should  
 reach that Age, as that one  
 of 4 years old should do it ;  
 and one third more likely,  
 than one of nine. On the  
 other hand, 'tis 5 to 4, that  
 one of 26 years old will die  
 before one of 16 ; and 6  
 to 5, that one of 36 will die  
 before one of 26 ; and 3  
 to 2, that the same person  
 of 36 shall die before him  
 of 16 : And so forward ac-  
 cording

cording to the Roots of :  
 ny other year of the decl  
 ning Age compared with  
 number between 4 and 5  
 which is the Root of 2  
 the most hopeful year for  
 Longævity, as the mean  
 between 16 and 26; and  
 the year of perfection, a  
 cording to the sense of *Ou*  
*Law*, and the Age for who  
 life a *Lease* is most valu  
 ble. To prove all which,  
 can produce the accom  
 of every Man, Woman, and  
 Child, within a certain P  
 rin



... of above 330 Souls ;  
... which particular Ages  
... being cast up, and added  
... together, and the Sum divi-  
... ed by the whole number of  
... souls, made the Quotient  
... between 15 and 16 ; which  
... call (if it be Constant or  
... uniform) the Age of that  
... parish, or numerous *Index*  
... Longævity there. Many  
... which Indexes for sever-  
... al times and places, would  
... make an useful Scale of Sa-  
... lubrity for those places; and  
... better Judg of Ayres than  
the

the conjectural Notions w  
commonly read and talk co  
And such a Scale the *King*  
might as easily make for a  
his Dominions, as I did  
this for this one Parish.

### The Twelfth Instance

In *Musick*.

**T**Ake a *Musical String*  
one end thereof be  
ing fastned; hang unto th  
other (over a convenient  
Bridg) any weight whic  
may strain it to some graw  
Musical Tone or Note; the

fect

At some other string of near  
 the same length, Unifone  
 hereunto. Lastly, instead  
 of the first weight, hang to  
 the first String the Quad-  
 ruple of the same weight;  
 and it will appear, that the  
 string with the quadruple  
 weight shall yield a Tone  
 an 8<sup>th</sup> or Diapason above  
 self, when singly charged.  
 The reason is, because the  
 quadruple weight doubles  
 the number of Vibrations,  
 2 being the Root of 4:)  
 and for that the *Ratio For-*  
*malis*

*malis* of Tones lieth in the  
 number of the Vibrations  
 and of the Diapasons,  
 the doubleness of such num-  
 bers. By the same Method  
 of hanging-on severall  
 weights at one end of the  
 same String, all Tones may  
 be produced, of which such a  
 String is capable. The  
 Tones or Notes also of lillies  
 Bells and Drums do follow  
 the same proportions of  
 their Tension and Mettals  
 so as able Artists can call  
 Bells in Tones assigned.

**TH**

The Thirteenth Instance,  
Of *Fire and Spirits.*

Et a Cylindrical Flat-bottom Vessel be filled with Water, and let it be carried, in what time one Lamp or Candle would make the water boyl through, or come up to its greatest heat: Then see, in how much lesser time, 2, 3, or 4 more like fires will hasten the same effect. I  
can-

cannot speak positively  
 hereof, but know from se-  
 veral Observations, that  
 the Acceleration abovesaid  
 shall not be made in Arith-  
 metical Proportion; for  
 asmuch as I know, that in  
 Fire-works great Fires are  
 more profitable than small  
 as in Brewers Coppens, and  
 Iron-works may be seen  
 wherein double Fires pro-  
 duce more than double ditto  
 patch or advantage. I shall  
 therefore suspend this mat-  
 ter, and pass to the measur-  
 ring

ing of the *Spirituousity* of  
*Liquors*, or in what pro-  
 portions several *Liquors*  
 contain more or less of in-  
 flammable or ardent parts.  
 Now in this case I conceive,  
 the Consideration of Roots  
 and Squares is also mate-  
 rial; for I understand by  
 strength or multitude of  
 spirits, the Space, greater  
 or lesser, into which such  
*Liquors* will be rarified,  
 will fill with Spirits:  
 as for example, if a Pint  
 of Water rarified into Va-  
 pour

pour will fill a Globe bo  
 of 3 foot Diameter ; and  
 Pint of rectified Spirit  
 Wine will fill a Globe  
 six foot diameter, or 8 tim  
 as large as that of Water  
 I shall say, that there iss  
 times as much Spirit or W  
 pour in one as in the othe  
 But if these Liquors we  
 put into open Lamps  
 Vessels, there the space  
 which the Spirits rise, a  
 the Roots, whose Squar  
 do shew the Spirituosity  
 those Liquors : *Ex. gr.* L  
 there



There be a Lamplike Vessel  
 common *Aquavita*; in  
 which place a Week as high  
 the flame will burn by  
 the rising of the Spirit un-  
 der it, suppose an inch a-  
 bove the surface of the Li-  
 quor: Now, let there be a  
 second Equal vessel with such  
 Spirit, as will rise up  
 higher, suppose to a Week  
 placed two inches above  
 the Surface; in this case, I  
 say, that the latter Liquor  
 is quadruple in strength or  
 content of Spirit to the for-  
 mer;

mer ; for 'tis certain, th  
as the Spirit riseth down  
upwards, so also it emitt  
or rarifieth it self down  
also sideways ; and con  
quently the quantity of  
Spirit or Vapour must  
quadruple ; and so of oth  
proportions.

**T**

The Fourteenth Instance,

*Of Rising and Falling Bodies ; but particularly of Waters in Pumps and River-streams.*

Et it be observed in the  
 — Transparent Pipe of a  
 forcing Pump, at how ma-  
 ny stroaks the Water is for-  
 ced from the Bottom to  
 the Top ; and let as many  
 marks be made at the seve-  
 ral places unto which the  
 F Water

Water mounted at every  
 stroak (which stroaks we  
 suppose to be all in Equall  
 Times;) it will appear, that  
 all the said Divisions will  
 be according to the Pro-  
 portions or the Logarithms  
 above-mentioned. As for  
 the Descents and Accelerations  
 of falling Bodies, the  
*Times* are the Roots of  
 these *Spaces*, which they  
 fall in the said times respec-  
 tively. The great effect  
 whereof we see in *Overshot*  
*Mills*, where a little water  
 falling

falling upon a Wheel of a large Diameter, produceth wonderful Effects ; the which may be well computed upon the Principles we hold forth.

Waters also have greater Forces in the above-mentioned proportions, as the mole or place whereat they issue is lower from their surface ; as may be seen in all Breast-and Undershot-Mills ; where it is pleasant to divide the Sinking of the water into Equal Spaces

ces, and to count the  
Clacks, Revolutions or  
Stroaks made within the  
Time of the waters sinking  
every such equal Space  
for therein the above-men-  
tioned Logarithmes may  
also be observed.

Unto this head may be  
referred the *Leakage* of  
*Ships*. For let there be a  
hole in a Ship somewhere  
under water; then let it be  
seen, what water comes in  
at the said hole, within any  
space of Time; then leav-  
thee

the like hole be made at double the perpendicular distance from the top of the water, and there shall come in four times as much as at the upper hole; and let a third be at three distances, and that shall admit 9 times as much, &c.

Again, let there be two Equal holes or Leaks in a Ship, the one at Head, and the other at Stern, and let the Ship be in motion; then the Leakage at the Head is composed of the pressure of

the water from the Surface  
 and of the Ships Motion  
 together. Moreover, if the  
 Ship make double way, the  
 Leakage will be quadruple  
 if treble way, noncuple, &c.  
 Wherefore to stop Leaks *a-*  
*fore*, the Ship must stop its  
 motion, lye by, or bear up  
 to go with the Wind and  
 Sea, &c.

Lastly, I shall add, that  
 the Swiftnesse of Waters  
 or River-streams, are  
 the Roots of the Power  
 that causes them; which  
 causes



causes are Steepness or De-  
scend in a sharper Angle  
from the Perpendicular.  
Wherefore knowing by ob-  
servations, what degree of  
Steepness causeth any de-  
gree of Swiftnes; hereby;  
and by our Doctrin, the  
Height of ground where a-  
ny River riseth above its  
fall into the Sea, may be  
computed.

The Fifteenth Instance,  
In the *Blast of Bellows.*

**I**N Iron-work Furnaces  
are the greatest and most  
regular moving Bellows  
that are any where used,  
the which are commonly  
turned by the evenest over-  
shot Wheels. Now the  
Times wherein these Bel-  
lows rise and fall, are the  
Roots of the Strength of  
such Bellows-blast upon  
these

the fire ; for rising in  
double Quickness admits  
double air in the same  
Time ; which being in like  
manner squeezed out a-  
gain, double Quickness  
makes double Expulsion,  
and consequently double  
Swiftness ; (the whole pas-  
sing through the same  
Wire-pipe in half the  
time ;) and double Swift-  
ness makes quadruple ef-  
fects upon the fire or Fur-  
nace, as aforesaid. :

The Sixteenth Instance,

In the Price of *several Commodities.*

Suppose a *Mast* for a small Ship be of 10 inches Diameter, and as is usual, of 70 foot in height, and be worth 40 s; then a *Mast* of 20 inches through and double length also shall not onely cost eight times as much, according to the Octuple quantity of  
Time

Timber it contains, but  
 shall cost 16 times as much  
 or 32 *l.* And by the same  
 Rule, a Mast of 40 inches  
 through shall cost 16 times  
 32 *l.* or 516 *l.* Of which  
 last Case there have been  
 some instances. But where  
 as it may be objected, That  
 there are no Masts of  
 four times 70, or 280 foot  
 long, I still say, that the  
 Rule holds in common pra-  
 ctice and dealing. For, if  
 a Mast of 10 inches thick  
 and 60 foot long, be worth

30 s

30 s; a Mast of 20 inches  
 throughout, and 80 foot  
 long, shall be worth 15 l.  
 And a Mast of 40 inches  
 thorough, and 100 foot  
 long (not 280 foot) shall  
 be worth near 100 l.

Moreover, suppose *Dia-*  
*monds* or *Pearls* be equal  
 and like in their Figures,  
 Waters, Colours, and Even-  
 ness, and differ onely in  
 their Weights and Magni-  
 tudes; I say, the Weights  
 are but the Roots of their  
 Prices, as in the Case a-  
 fore-

foregoing. So a Diamond  
of Decuple weight, is of  
Centuple value. The same  
may be said of Looking-  
glasses-Plates. I might add,  
that the Loadstone A, if it  
take up 10 times more than  
the Loadstone B, may be  
also of Centuple value.

Lastly, A Tun of ex-  
treme large *Timber* may be  
worth two Tuns of ordi-  
nary dimensions; which  
is the cause of the dear-  
ness of great Shipping a-  
bove small; for the Hull  
of

of a Vessel of 40 Tuns may  
 be worth but 3 *l.* per Tun  
 whereas the Hull of a Vessel  
 of 1000 Tuns may be  
 worth near 15 *l.* per Tun  
 From whence arises a Rule  
 how by any Ships Burthen  
 to know her worth by the  
 Tun, with the Number and  
 Size of her Ordnance, &c.

800

$$\begin{array}{r}
 80 \\
 3 \\
 \hline
 940
 \end{array}$$

1000

$$\begin{array}{r}
 1000 \\
 15 \\
 \hline
 15000
 \end{array}$$

Th



## The Seventeenth Instance,

In *Mill-Dams, Sea-Bancks,*  
and *Bulwarks of For-*  
*tresses.*

Suppose any Wall, Dam,  
or Banck, to be just  
sufficient to keep out or  
resist the Sea, or other  
Stream against the appulse  
of its waters, being of a cer-  
tain force; I say, that to  
make this Wall or Damm  
strong enough against a  
double

double swiftness of appulse, it must be augmented by quadruple thickness; and if it must be made sufficient against the greatest violence which ever was observed, then that violence being known, is the Root of the number by which the Walls thickness must be augmented.

So Cannon-Bullets do Execution or batter in *duplicitâ ratione* of their swiftness; and therefore Ramperts must be strong and

and thick in *duplicatâ ra-*  
*one* of the said swiftness,  
 which depends upon the  
 Distance of the Battery,  
 and the degrees of Tardati-  
 on, which Bullets make in  
 every part of their way be-  
 tween the Gun and the  
 Rampert, which they are  
 to batter. Where note,  
 that Bullets commonly beat  
 out a Cone of Wall, whose  
*Vertex* is in the Bullets En-  
 try, and like the Conical  
*Fovea* to be seen in the  
 Sand of an Hourglass.

The

## The Eighteenth Instance

In the Compression of Yielding and Elastic Bodies  
as Wooll, &c.

Suppose some Cylindrical or other parallell sided Vessel, fill'd with Wool, or Down, or Feathers, or other *Elastic* Materials; let the same be covered with a moveable Head (such as in pressing of Pilchards they call a Buck-

buckler; ) then first ob-  
 serve, how low the Buck-  
 ler descendeth by its own  
 weight; and then upon  
 this Head or Buckler lay  
 a triple weight, to make  
 the whole quadruple, and  
 it will appear, that the  
 buckler will sink but just  
 as much lower; and being  
 conjoined, another like  
 space lower: So as the se-  
 veral Spaces of Depressi-  
 ons are the Roots of the  
 depressing Powers. From  
 hence may be seen, how  
 the

the Force must be increas  
 ed at every Turn or Three  
 of a Screw-Prefs; which  
 being done according  
 the proportions here un  
 derstood, I doubt not  
 but a Light Substance with  
 a convenient *Apparatus*  
 might be compressed unto  
 the Density and Weight  
 ven of Gold. But, that Si  
 ver might be so condens'  
 I made no question, till  
 heard of some Anomaly in  
 the practice, which I mu  
 better consider of. The  
 further

further Truth whereof doth  
 appear in the *Under-water-*  
*Air* within the Vessels of  
*Water-Divers*, who the low-  
 er they go, do find their  
 Stock of Air more and  
 more to shrink; and that  
 according to the Roots of  
 the Quantities of the  
 super-incumbent Water or  
 Weight. In like manner  
 take a Bow, and hang  
 any weight to the middle  
 of its string, and observe  
 how low it draweth the said  
 string. Now, if you shall  
 qua-

quadruple the same weight  
 it will draw down double  
 the first distance, and now  
 couple will draw it down  
 treble, &c. So as in  
 drawn Bow, let the Arre  
 be divided into *quocunq*  
*partes*, each equal part  
 the Tension carrieth the  
 Arrow to an Equal D  
 stance, notwithstanding  
 each equal part of the Ten  
 sion was made by Unequa  
 power, and that each equal  
 Space or Part also of the  
 Arrows first flight require  
 Unequa



Inequal Force, *viz.* least  
 strength at first, and most  
 last; and that, in the  
 proportion first mention-  
 ed. So in the *Fuze* of a  
 Watch, the greatest strength  
 of the Spring is made to  
 work upon the shortest *Ve-*  
*is*; and the least upon the  
 longest, so as to equalize  
 the whole. The like also  
 happens in the *Traction* of  
*Muscles* upon two Bones  
 with a turning Joynt be-  
 tween them; which Bones  
 and *Muscles* make a Tri-  
 angle

angle, whereof the Muscle  
is the Base, subtending the  
Angle-Joynt. Now in the  
working, the Muscle  
strongest, when the *VeE*  
is smallest, as lying more  
obliquely; and *vice versa*  
when the Muscle and mo-  
ving Bone come to make  
right Angle.

*An Appendix*

OF

*E L A S T I C I T Y .*

**H**AVING done with the  
 Consideration of du-  
 plicate and subduplicate  
 proportion in *Elastic* Bo-  
 dies and Materials, I hope  
 it will not be amiss to sub-  
 join a short Appendix of  
*Elasticity it self*, whereby  
 to draw forth the better  
 G thoughts

thoughts of other men from  
 Countenance or Correction  
 on. Wherefore I say  
 followeth; *viz.*

First, Supposing every  
 Body to have a *Figure* or  
 Positure of its own, out  
 which it may be disturbed  
 by *External Force*; I say  
 that *Elasticity* is the power  
 of recovering that *Figure*  
 upon removal of such  
 Force.

2. I think it easiest to  
 consider *Elastic, Springing*  
 or *Resilient Bodies*, as *Laminae*  
*minerae*

*Wire, Laths, or Lines*; so  
 as a streight Lath, being  
 by force bent *circularly*,  
 doth upon the removal of  
 that Force, return to be  
 streight again by its *Elasti-*  
*city*; and a *Circular Hoop*  
 being forced streight, leaps  
 back into its own crooked-  
 ness by its *Elasticity*.

3. *Elastic Bodies* in  
 their returns do overshoot  
 their own Natural Posture,  
 and vibrate *cis citrà* the  
 point they seek, as doth a  
*pendulum*, or *Magnetic-*  
 G 2 *Needle,*

*Needle*, till at length they  
rest; the one in his *Perpendicular*, and the other  
in his *Meridian*.

4. An *Elastic Body* is a  
gross *Tangible Body*, which  
is made of *Corpuscles*,  
the smallest Bodies that can  
possibly be *seen*; and these  
*Corpuscles* are made of  
*atoms*, or the smallest bodies  
in Nature (such as where  
a *Million* doth not perhaps  
make one of the *Corpuscles*  
last mentioned.)

5. I know no reason, why we may not, upon occasion, suppose *Atoms* to be of *several Figures* and *Magnitudes*, provided we suppose them *immutable*, such as *Corpuscles* are not; gross tangible Bodies being very mutable by the various Additions and De-  
 structions that befall them.

6. I suppose in every *Atom* three such points as we all see and know to be in the *Globe of the Earth*, and in every *Magnet*, viz. two  
 G 3 Poles

*Poles* in its *Superficies*, around  
 a *Central* point within its  
 substance, which I call its  
*Byas*. The *Heavens* all  
 visibly have their *Poles*  
 and must have a *Center*  
*Gravity* or *Magnitude*, or  
 some other *Central* and pre-  
 dominant *Point*.

7. I suppose every *Atom*  
 may move about his  
 own *Axis*, and about other  
*Atoms* also, as the *Moon*  
 does about the *Earth*; *Venus*  
 and *Mercury* about the  
*Sun*; and the *Satellites*  
*Jovis*



*Jovis* about *Jupiter*, &c.

8. I suppose, that the *Byas* of one Atome may have a tendency towards the *Byas* of another near it, and that the *Byasses* of many Atoms may tend to some common point without them; as we see in *Electrical* Bodies, and in the *Globular drops* of Water and *Quicksilver*, and all *Mucilaginous* Substances.

9. I suppose, that all Atoms have, like a *Magnet*,

two Motions, one of Gravity, whereby it tendeth towards the Center of the Earth, and the other of Verticity, by which it tendeth towards the Earths Poles, and whereby Magnets joyn to each other by their *Opposite Poles*.

10. All Atoms by their Motion of *Verticity* or *Polarity*, would draw themselves, like Magnets, into a streight Line, by setting all their Axes in *directum* to each other; did not the  
 Moti-

Motion of their respective  
 Byasses towards each other,  
 and towards other Points,  
 curb them into a *Triangle*,  
 whereof the *Two Axes* of  
*Two Atoms* are two sides,  
 and the distance between  
 the Byass of each making  
 the third side : Wherefore  
 call the *Polar Motion* a-  
 bove-mentioned, the Mo-  
 tion of *Rectitude* ; and the  
 Motion of the *Bi-sses*, the  
 Motion of *Angularity* or  
*Curvity*, or the Angular or  
 Curve Motion.

11. I suppose, that all these Motions may be of different *Velocities*, and that by *Contra-colluctations* they ballance each other, sometimes into *seeming* rest: I say, *seeming*, because perhaps there is *no* rest in Nature.

Lastly, I might suppose (even without a Metaphor) that Atoms are also *Male* and *Female*, and the *Active* and *Susceptive* Principles of all things; and that the above-named *Byasses* are the

the Points of Coition: For,  
 that *Male* and *Female* ex-  
 tend further than to *Ani-*  
*mals*, is plain enough; the  
 fall of *Acorns* into the  
 ground, being the Coition  
 of Oaks with the Earth.  
 Nor is it absurd to think,  
 that the words in *Genesis*,  
 [ *Male and Female crea-*  
*ted be them* ] may begin to  
 take effect, even in the  
 smallest parts of the *first*  
*Matter*. For although the  
 words were spoken onely  
 of *Man*; yet we see they  
 certain-

certainly refer to other Animals, and to *Vegetables* in manner aforesaid, and consequently not improbably to all other *Principles of Generation*.

### *Conclusion.*

To Conclude, I hope I may say, that these my *Principles*, are *Principles indeed*; for there can be no *fewer* nor *easier* than *Matter* and *Motion*. My *Matter* is so simple, as I take notice

of nothing in each Atome,  
 but of *three such Points* as  
 are in the Heavens, the  
 Earth, in Magnets, and in  
 many other Bodies. Nor  
 do I suppose any *Motions*,  
 but what we see in the  
 greater parts of the Uni-  
 verse, and in the parts of  
 the Earth and Sea.

Again, all the *Motions*  
 I fancy in my Atoms, may  
 be represented in gross  
*Tangible* Bodies, and con-  
 sequently may be made *in-*  
*telligible* and *examinable*.

More-

Moreover, I hope none of my Suppositions are inconsistent with each other, nor do necessarily infer any absurdity or falsehood.

And lastly, I hope they solve all the *Phænomena* of *Elasticity*, and, as I think of *Hardness*, *Fixedness*, *Tenacity*, *Fluidity*, *Heat*, *Moisture*, *Fermentation*, and the rest. All which is humbly submitted to the Censure of this *Society*; whose *Atoms* or inseparable Members I wish may happily

Con-



[ 135 ]

Conglomerate, and Unite  
hemselves into the most  
fixed and most noble Bo-  
dies amongst the Sons of  
Men.

---

*FINIS.*

---

What is it? Johnson's death.

When Ethel Cheever Robinson  
had 2 sacks of mail of her

read not. Tell you the story.

